CSL715: Biomedical Image Processing and Analysis
Term Project

Lesion Segmentation & Disease Classification for ISIC 2018 Dataset

Lesion Segmentation

Challenges

- Images are of Variable Sizes
- Large Image Sizes
- Very low contrast and texture variance for lesion cells to normal cells (as seen visually)

Proposed Methods

- Fixed Image Size of 384x512x3 (3:4)
- Two Variations of U-Net used
- ‘BinaryCrossEntropy’ plus ‘JaccardLoss’ used for loss calculation
- Data Augmentation (both Spatial and Intensity based)
- Preprocessing for Contrast Enhancement & Gamma Correction to Testing Images

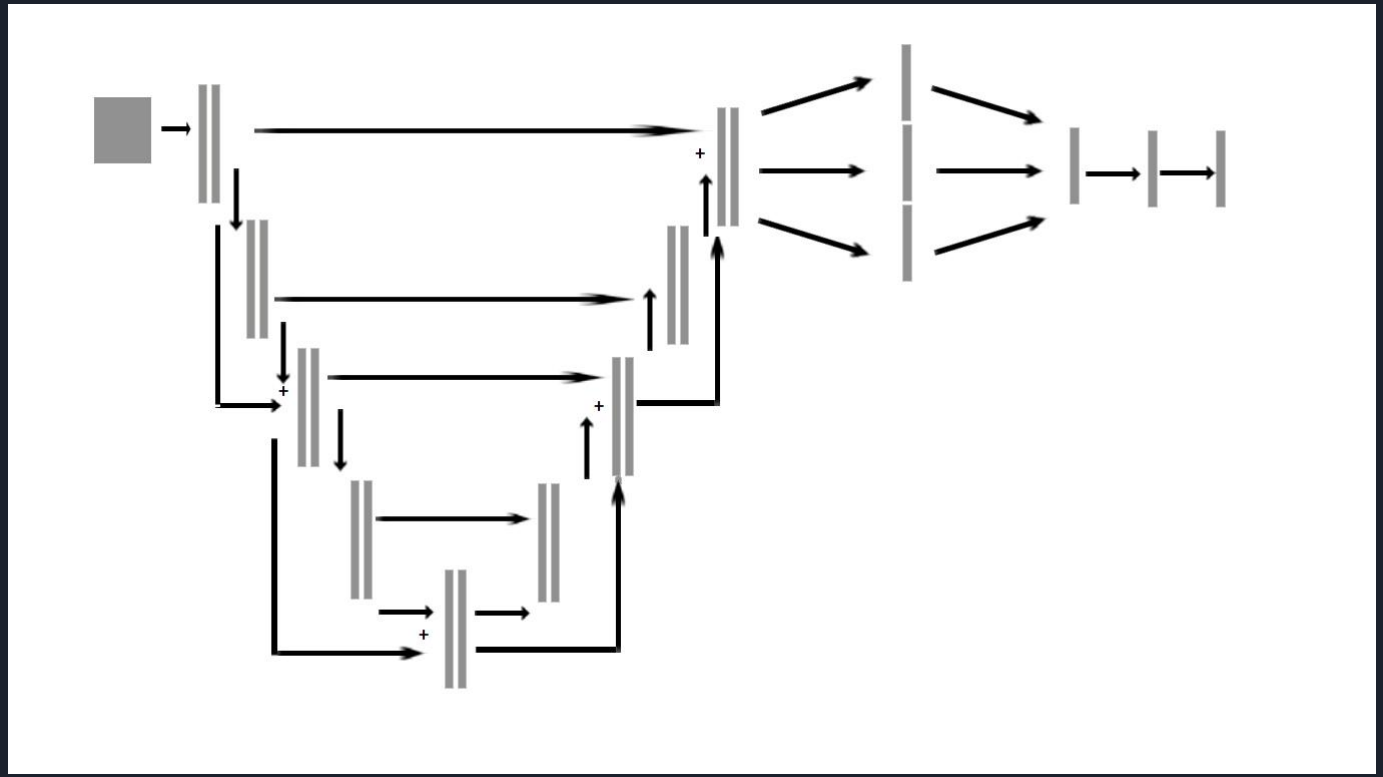
Model Architecture

- Model 1: U-Net Model + Skip Connections + Inception Module in the end
- Model 2: U-Net Model + Pyramidal Scaling + Inception Module in the end + High number of Image Augmentation Techniques
- Model 3: U-Net Model + Pyramidal Scaling + Inception Module in the end + Low number of Image Augmentation Techniques

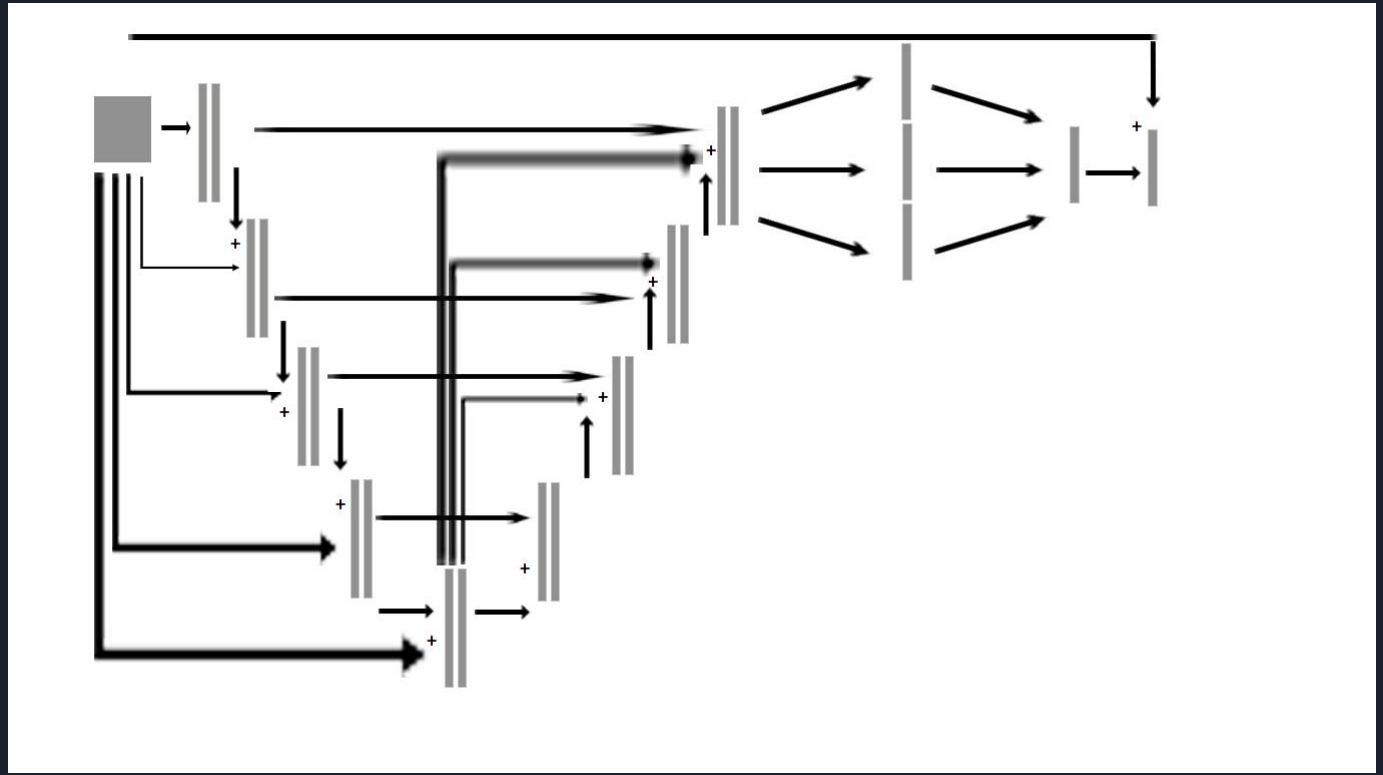
Proposed Image Augmentations

- Flip Horizontal/Flip Vertical
- Angle Rotation
- Brightness Change
- Contrast Variation
- Gamma Correction
- Hue Variation
- Saturation

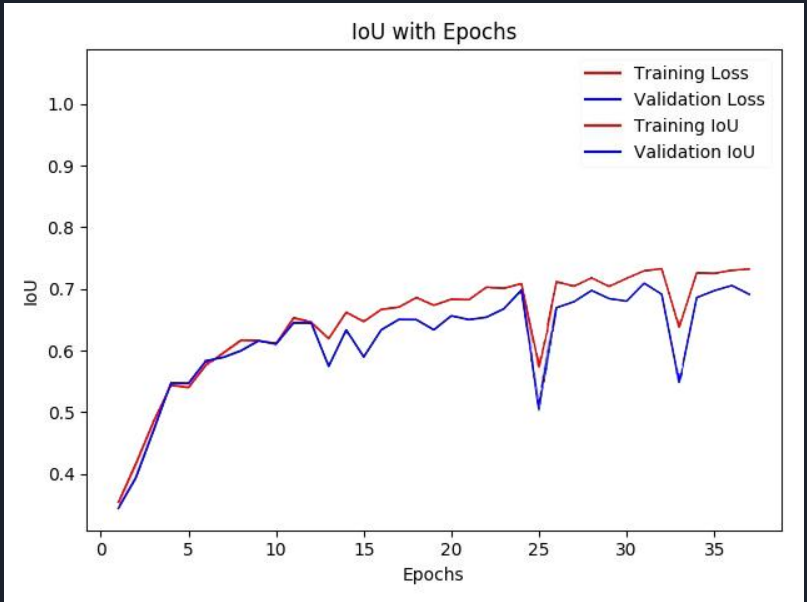
Model 1: Architecture

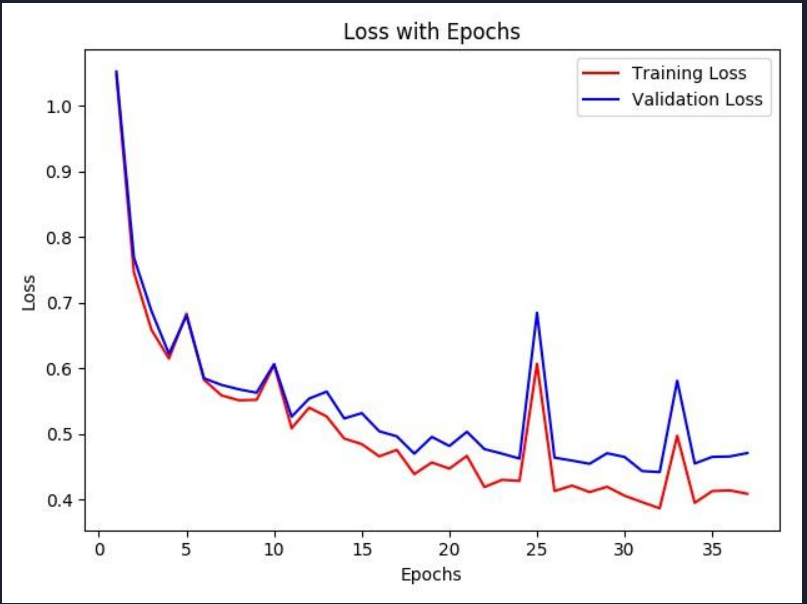


Model 2 & 3: Architecture

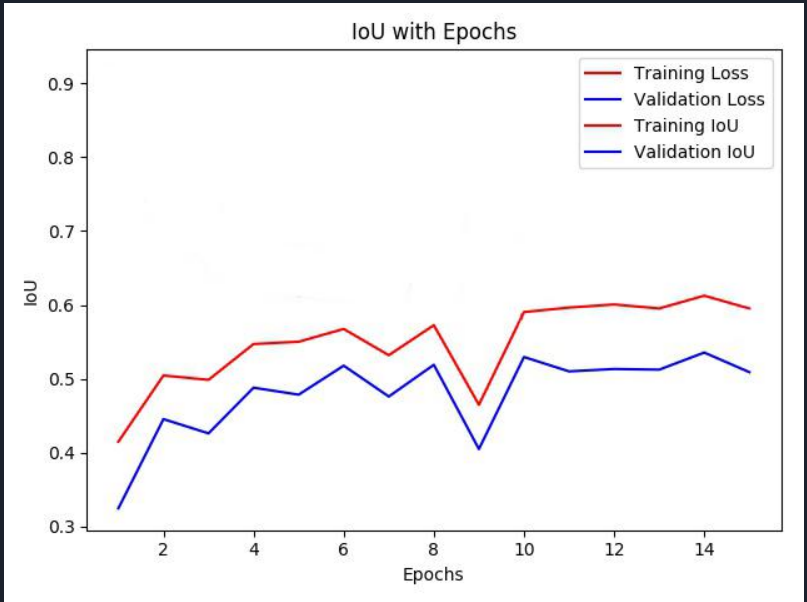


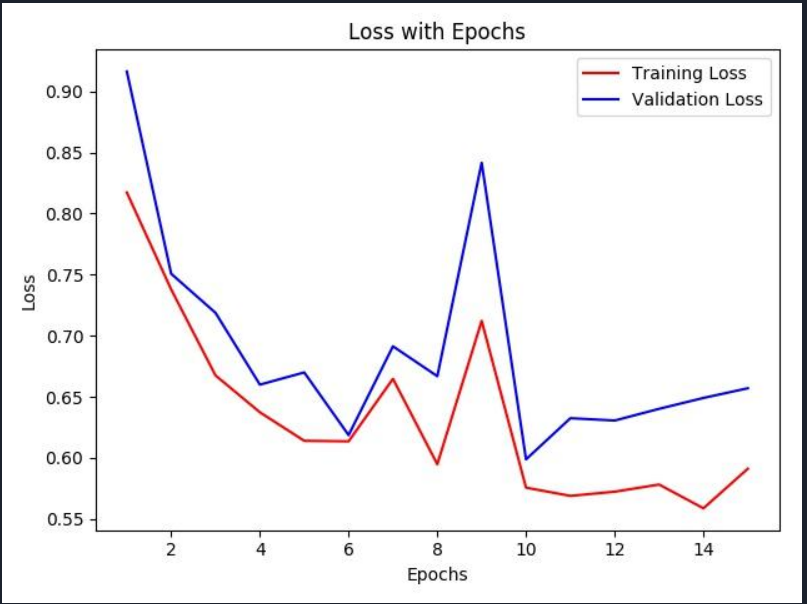
Model 1: Loss and Accuracy



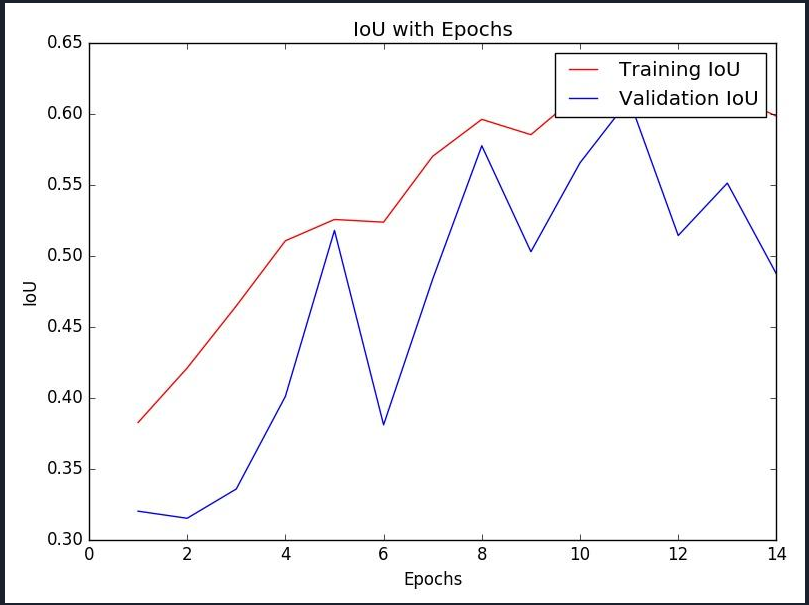


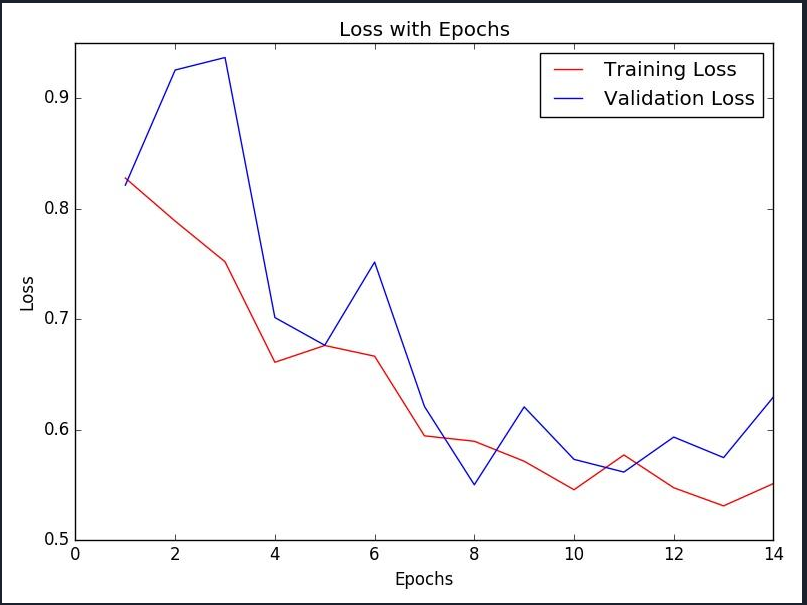
Model 2: Loss and Accuracy



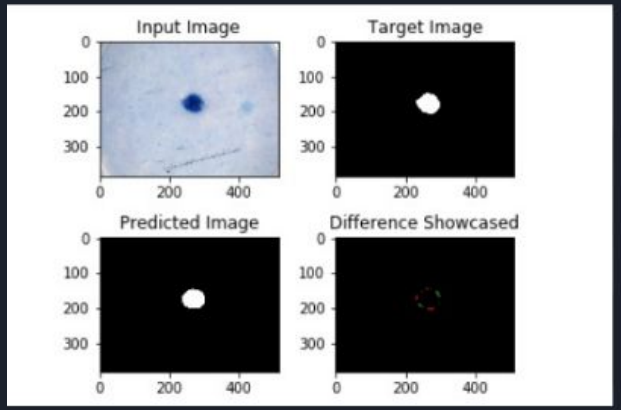


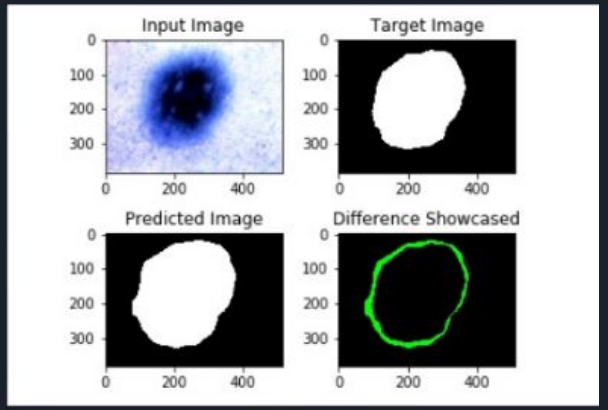
Model 3: Loss and Accuracy

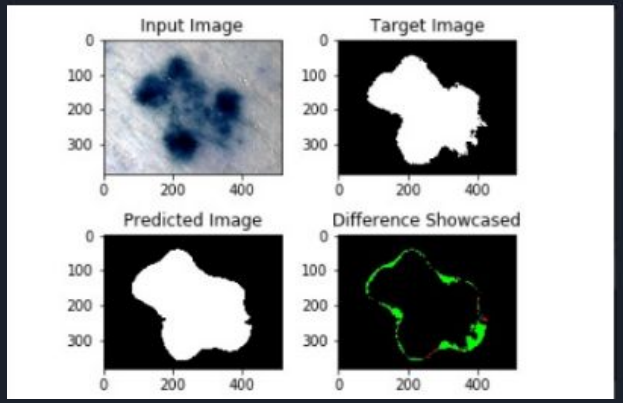


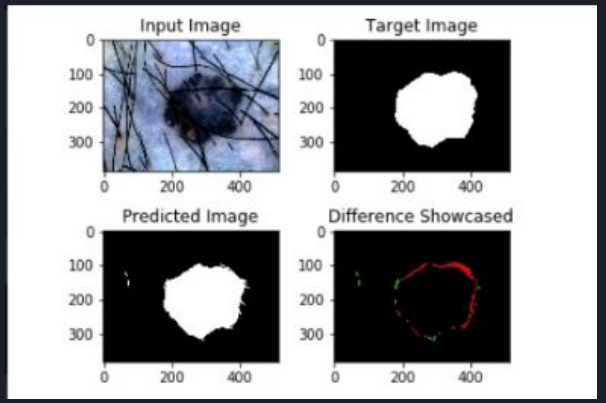


Good Segmentation Examples

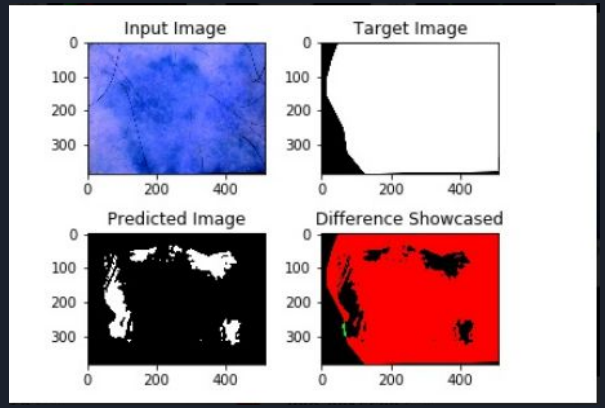


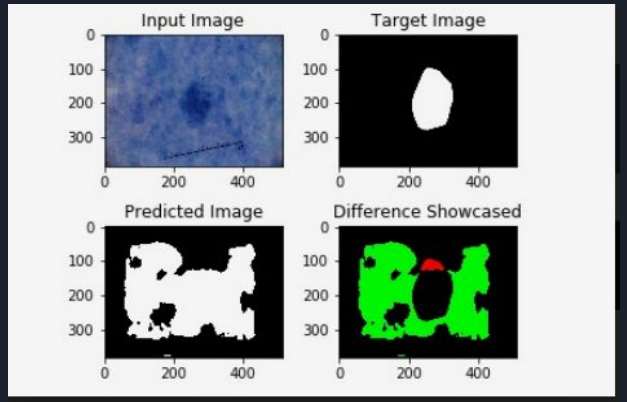


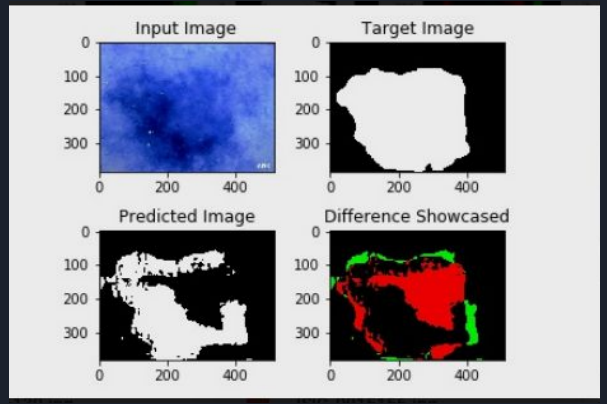


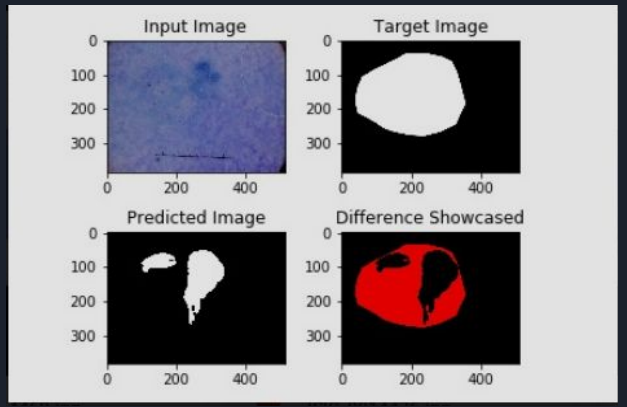


Failed Segmentation Examples









Results

- Model1: Test IoU is 0.677
- Model2: Test IoU is 0.513
- Model3: Test IoU is 0.611

Inferences

- Image Augmentation didn’t help much
- Pyramidal Model didn’t seem useful
- Perhaps more fine-tuning of the model required

Disease Classification

```
"AKIEC": 327
 "BCC": 514
 "BKL": 1099
  "DF": 115
 "MEL": 1113
  "NV": 6705
"VASC": 142
```

Challenges

- Highly Imbalanced Dataset
- Handful Samples for Few Classes
- Large Image Size
- Very High Variance in Images for each class (NV with 6700 Instances)

Proposed Methods

- Weighted sampling of Instances for classes with higher number of Images
- Weighted Loss for Cross Entropy
- Image Augmentation (dropped due to no improvement)
  - Random Horizontal Flip
  - Random Vertical Flip
  - Color Jitter (Brightness, Hue, Contrast)

Model Architecture

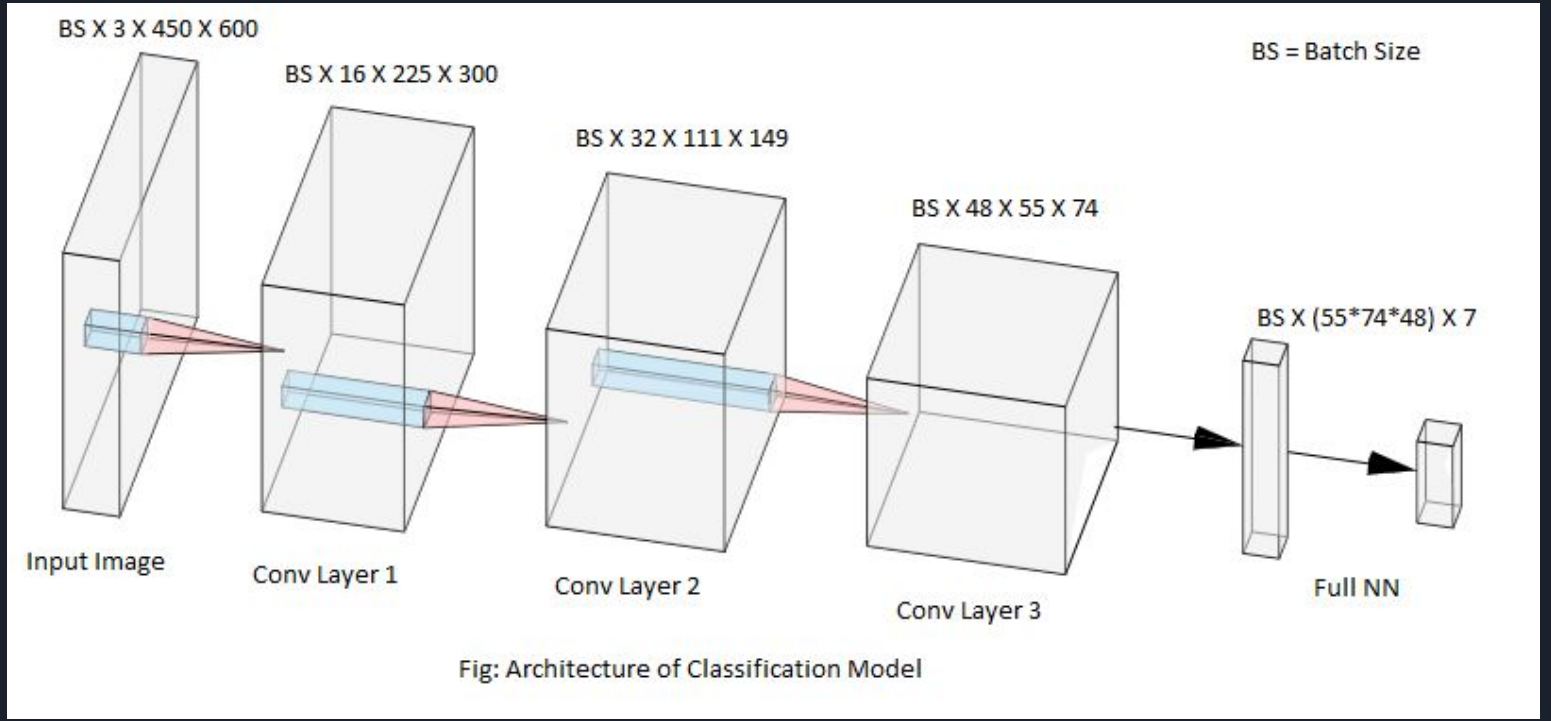
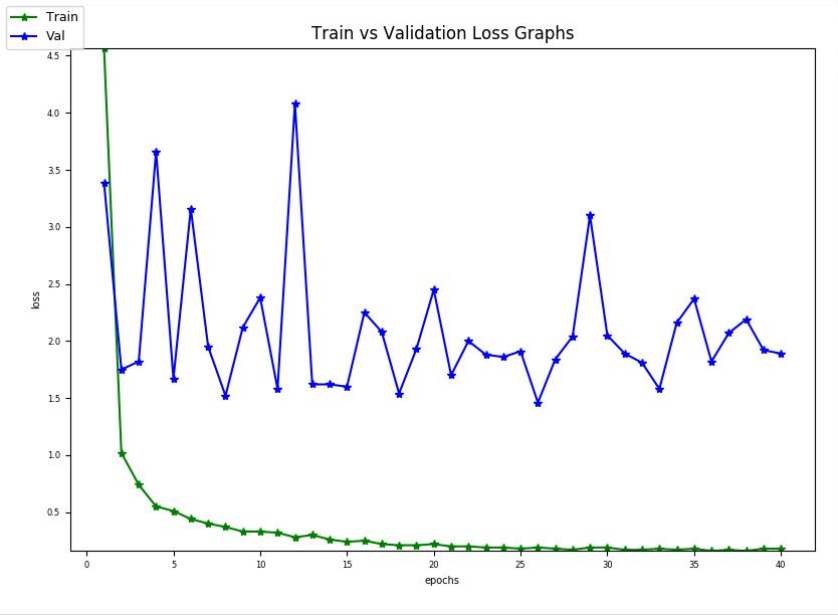
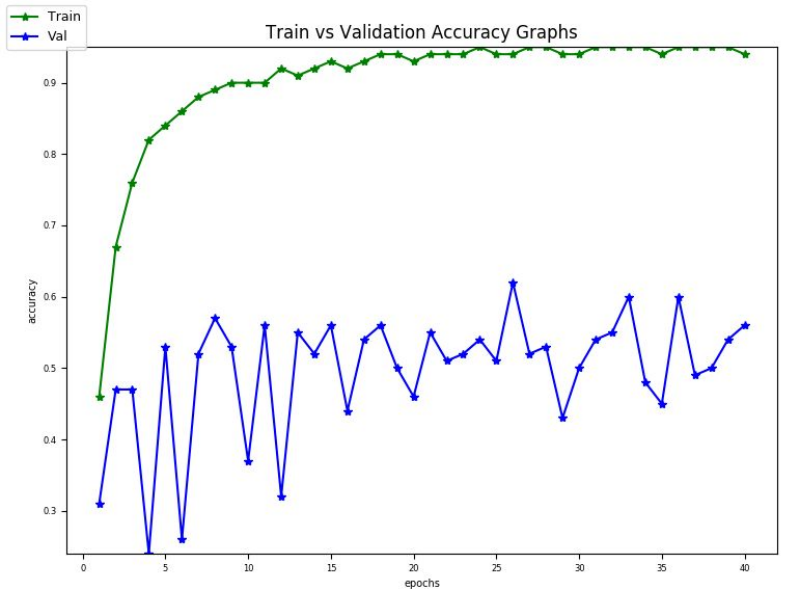


Fig: Architecture of Classification Model

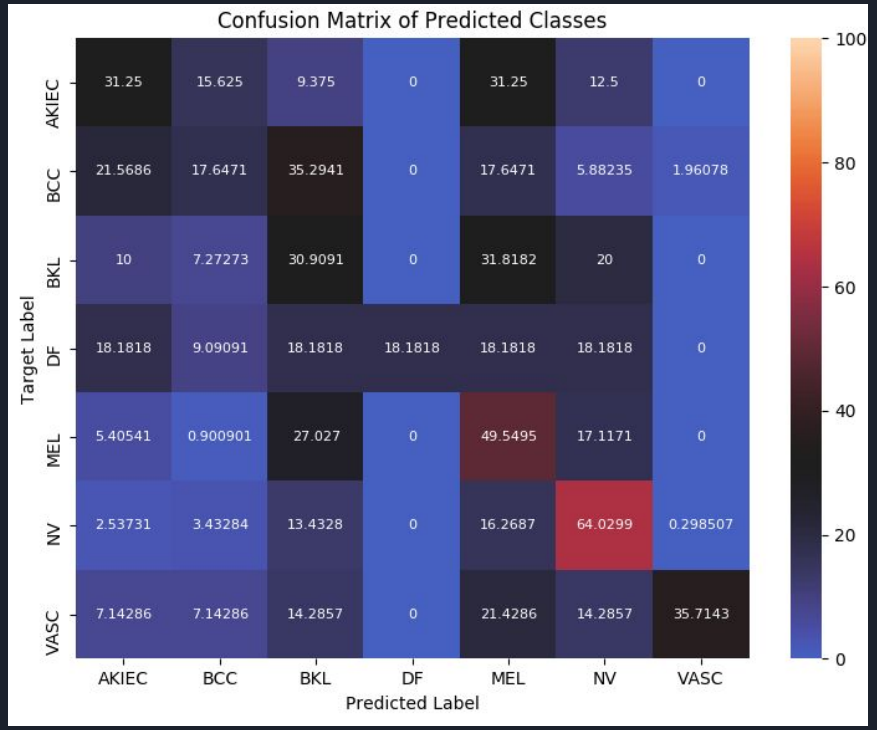
Losses and Accuracies





Result: Final Test Accuracy is coming out to be ~54%.

Confusion Matrix



Inferences

- Highly Imbalanced Dataset affects the learning of the model greatly
- Our proposed methods are useful to some extent
- Result & Confusion Matrix shows that model could be trained to be made independent of number of Instances in a class

Conclusion

- The ISIC 2018 is much harder to work on
- Large Image Sizes in Segmentation demands powerful workstation
- The validation accuracy in classification is fickling per epoch
- Most of the Image Augmentation techniques didn't work for our models

Future Work

- Post-processing could be applied on Segmented Image
- Different sampling method could be used for classification
- Residual Networks might be useful for classification
- Some boundary enhancement techniques could be used for segmentation